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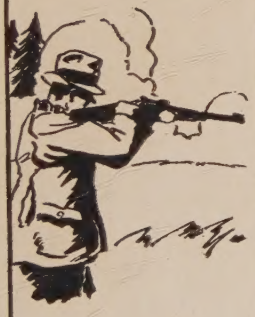


DIVISION OF FISH AND GAME

Board of Commissioners of
Agriculture and Forestry

Honolulu, Hawaii

A PROGRESS REPORT OF PROJECT 5-R-1.

"A Study of the Pheasant, California Quail, and Lace Necked Dove in Hawaii"

FISH AND GAME DIVISION

Special Bulletin
#3

J. Donald Smith
Game Conservationist
John R. Woodworth
Wildlife Biologist

BOARD OF AGRICULTURE AND FORESTRY
Honolulu T.H.

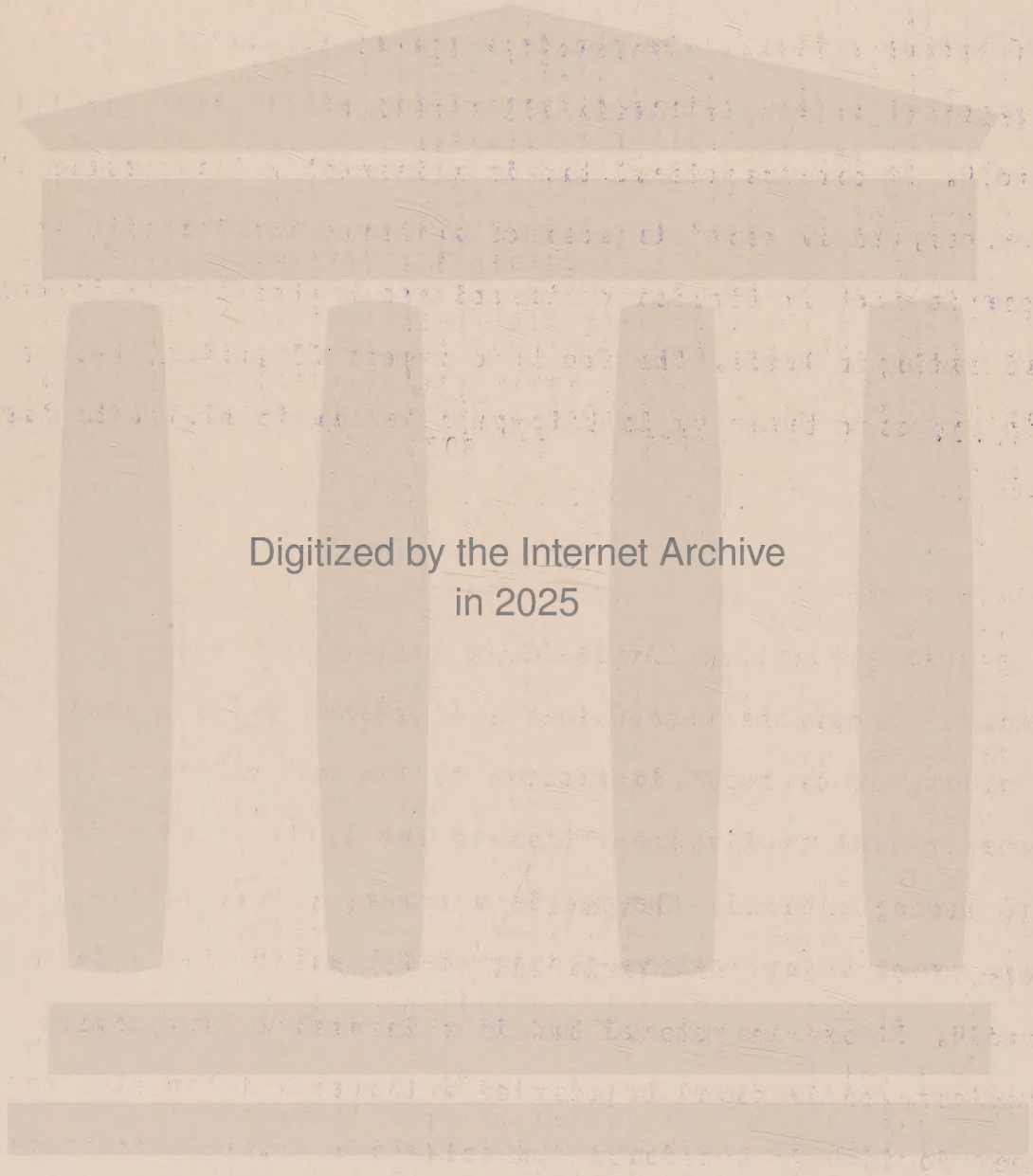
Introduction to Progress Report of Project
5 - R - 1 — Vol. 1; No. 1.

June 15, 1949 marked the beginning of an intensive study of the pheasant, California Valley quail, and the lace-necked dove in Hawaii. The work is being financed under the Federal Aid to Wildlife Restoration Act wherein the U. S. Fish and Wildlife Service underwrites 75% of the cost of wildlife restoration work carried on by the states and Territories participating in the Act.

At the conclusion of each 3 month period, a Progress Report is prepared by the personnel doing the wildlife work under a Federal Aid project. The purpose of the quarterly reports is to indicate to the Fish and Wildlife Service that the game restoration work is being carried out efficiently and in accordance with the work plans of the wildlife project approved by the Federal Service. The report also provides an incentive to summarize work results at frequent intervals. This is especially valuable in research projects covering work over long periods as it keeps the researcher on the "track"; many times preventing diversion of effort along interesting but not pertinent lines.

The following report is the first Quarterly Report of the progress made under the Wildlife Research Project 5-R-1, titled a "Study of the Ring-necked pheasant, California Valley Quail, and the Lace-necked dove in Hawaii". It contains material that is of interest to the sportsmen of the Territory, and the report is presented to them so that they will know the manner in which the Division of Fish and Game is attempting to improve game bird hunting in Hawaii. The plan is to present all Quarterly Reports of this project to the public in ditto-graph form and to publish the final report

as a research bulletin similar in style to the report recently issued by the Board of Agriculture and Forestry titled, "A Reconnaissance Survey of the Game Birds in Hawaii," by Schwartz and Schwartz.



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STATE Territory of Hawaii

PROJECT NO. FR.5R1

DATE July 1, 1949 to
September 30, 1949

VOL. 1 NO. 1

PROGRESS REPORT

SURVEYS AND INVESTIGATIONS

as required by

FEDERAL AID IN WILDLIFE RESTORATION ACT

1. Title of Project: Pheasant, Quail and Lace-necked Dove Studies

2. Leaders: John R. Woodworth and J. Donald Smith
David H. Woodside, Assistant

3. Report of Progress:

BROOD STUDIES

Brood counts of pheasants on the island of Hawaii were made the last week of June and first week of July, 1949, in the Waikii area. Further counts were made throughout the island in connection with censusing during the month of July.

An attempt was made to flush all of the birds in every brood that were seen in the Waikii area. The age of the birds was estimated as to age class; Class I = less than $\frac{1}{4}$ grown, Class II = $\frac{1}{4}$ - $\frac{1}{2}$ grown, Class III = $\frac{1}{2}$ - 3/4 grown, Class IV = 3/4 - Full grown.

Table I shows the various ratios and percentages obtained from this data. It may be noticed that the pheasant brood average is only 3 even in the Waikii area which has the highest density of any area in the Hawaiian Islands.

Also, more than fifty per cent of the hens seen were without broods.

Due to unavoidable circumstances this work was started late in the season which results in the high percentage of Class III and Class IV young.

Table II shows ratios and brood data obtained from censusing on Hawaii from July 7, 1949 to July 26, 1949. As the season progressed the broods in Classes I and II dropped out leaving most of the birds in Classes III and IV which would indicate a noticeable lack of re-nesting activity. This lack of such activity has become more noticeable since subsequent observations have not shown any Class I and II birds.

The data tabulated at this time is insufficient to give accurate ratios and percentages. Similar data is being compiled constantly and more accurate conclusions will be drawn at the completion of the project.

ANNUAL CENSUS

The annual censusing of pheasant and quail populations in the Hawaiian Islands was conducted from July 7, 1949 until August 17, 1949. The censusing was done on approximately the same dates as last year on the same areas, and by the same methods in order to give usable results when compared to last year's census figures.

It is known that calendar dates do not necessarily represent the same period in the breeding cycle each year; however, due to the lack of data, calendar dates were the only usable statistics available. In the future, when sufficient data is compiled, an effort will be made to make the censuses during the same period in the breeding season as the preceding year.

Three methods of censusing were used: (1) One man strip count. This is a typical strip count where flushing distances are averaged to give total square yards covered on the strip. In order to obtain the number of

birds per square mile, the following formula is used:

$$\frac{\text{Acres covered}}{\text{Birds seen}} = \frac{640 \text{ acres}}{X}$$

This method is used in the open ranch land areas such as those found west of Pohakuloa and on the Parker Ranch (Plate I).

(2) A two-man strip count. Two men walk through a designated area approximately 20 yards apart. It is assumed that all of the birds between the two men will flush but not necessarily the birds outside of this strip. The 20 yard strip is considered definitely covered, but for additional area an average of the flushing distances beyond ten yards from the center line is taken. The number of birds per square mile is figured as in method (1). This method is used in dense cover such as that found in the eastern half of Pohakuloa. It is impossible for one man to count all of the quail that are flushed when the trees are so dense. (Plate 2).

(3) Road count. An automobile is used in areas where poor unused roads pass through good habitat. The densities are computed in the same manner as in number one, using the road as the center line.

HAWAII

Censusing of sample areas on the island of Hawaii was conducted during the month of July. The data concerning the densities of ring-necked pheasant, California quail and Japanese quail is tabulated in Table III. This table is a comparison between population estimates made by Schwartz in 1947 and the census figures obtained in 1948 and 1949. Four additional areas, Ainahou, Horse Pasture, between Waikii and Pohakuloa and above Puu Laau, were censused in 1949. The number of strip miles covered in 1949 is in the column on the right. Map No. 1 indicates the areas censused and a comparison of population densities over the past three years.

The trend of the census indicates a general increase in ring-necked pheasant and California quail populations while the Japanese quail seem to have increased in some areas and decreased in others. This information coincides very favorably with the opinion of the local people who were questioned about densities compared with past seasons. Of the fifteen ranch managers, game wardens and foresters questioned, all but one said that they had seen more pheasants and California quail this year than they had since the war began in 1941.

MAUI

Censusing was continued on the island of Maui for the first two weeks in August. The same methods were employed as those used on Hawaii in July. The data concerning the densities of pheasants, California quail and Japanese quail is tabulated in Table IV. Two new areas, Waikapu and Honokohau, were censused in 1949.

The population trend seems to be in the opposite direction from that on Hawaii. On Maui, the populations are on a general decrease except in the Puu Nianiau area. This exception can probably be attributed to the planting of three hundred pheasants last year on Puu Nianiau by a local gun club. There are numerous areas of apparently excellent habitat on Maui which have very low densities. The information obtained again coincided favorably with the opinion of local ranchers and game wardens that were questioned. Eight of the ten ranch managers, wardens and Park rangers questioned believed there are fewer birds on Maui this year than there were last year.

Map No. 2 indicates the areas censused and the density comparisons for ring-necked pheasant, California quail and Japanese quail.

LANAI

One man strip counts were made on the "Pineapple Island". The

weedy ratoon pineapple fields offer excellent habitat and the density appears to be very uniform around the entire cultivated area. Table IV is a comparison between the estimates by Schwartz in 1947 and the figures obtained in 1949. There was no census made in 1948.

MOLOKAI

The California quail on the Kaunakakai Game Management Area appear to be increasing steadily. This can probably be attributed to the management practices carried on there. Table IV is a comparison between estimates by Schwartz made in 1947 and the census figures made in May 1949 and August 1949.

OAHU AND KAUI

One man strip counts were made in sample areas on the islands of Oahu and Kauai. The Oahu pheasant population has taken a definite drop. This might be attributed to overhunting since this island has a high population of hunters and a small hunting area. Kauai seems to remain fairly stable except in the area above Kekaha. The data is tabulated in Table V and map number 3 gives the locations and comparisons between 1947 and 1949. No census was made in 1948.

TRAPPING AND BANDING CALIFORNIA QUAIL AND RING-NECKED PHEASANTS ON HAWAII

The trapping and banding of California quail was begun on July 14, 1949 on the Pohakuloa game management area. From that date through July 29, only two traps were used. Trapping was discontinued during the greater part of the month of August, but beginning September 1, 1949, trapping of both pheasant and quail was again started on a full time basis.

The objectives of this study are to determine the range of pheasants and quail densities in the area where the birds were banded.

Quail banding is being carried on entirely in the Pohakuloa game management area on Hawaii. Pheasant trapping is taking place on the Parker Ranch in the Waikii area.

California type quail traps and modifications of the type described by Stoddard which are constructed of both half inch and quarter inch hardware cloth are being used. (Plate 3). These traps are placed where quail are known to congregate. In the game management area, the game bird watering units offer excellent trap sites. Scratch feed and canary seed are used as bait. The traps are left in an area until it is certain that there are no birds present or until most of the quail have been banded which is determined by the proportion of "repeats" which occur in a trap. The traps are visited at least twice a day, both in the morning and evening, and once during mid-day if possible. Numbered, aluminum, butt-end bands marked Territory Fish and Game are fastened on either leg. (Plate 4). Each bird trapped is banded and a permanent record kept of the band number, sex, age, location and condition. Repeats are also recorded as to date and location. The traps are located at the areas indicated on Map 4. A total of 170 California Valley quail were trapped between July 14 and September 30, 1949.

The data concerning California quail is tabulated in Table VI. To date there are almost two cocks to each hen and two adults for each juvenile; however, trapping will be continued throughout October and at that time there may be a change in the ratios.

Some information concerning their range has been obtained by retrapping. Three quail trapped at water unit No. 2 (Map 4) on September 8, 1949, were retrapped at water unit No. 19 September 21, 1949. This indicates a range of approximately one mile. One quail trapped at the nene pen (Map 4) was consequently retrapped at the horse paddock five days later. This distance is

slightly over one-half mile. All other quail re-trapped were caught at the original banding site.

Considerable difficulty with predators was encountered during the trapping operation. Feral cats, feral pigs and mongooses either destroyed quail in the traps or destroyed the traps. 7.8% of the quail trapped have been destroyed by predators. Plates 5 and 6 show trap destruction by feral pigs. Apparently pigs are attracted by the scratch feed and push the traps aside in order to get at the food. Feral cats have killed five quail that were in the traps. Steps are being taken to trap and kill the predators. To date, 10 pigs, 5 cats, and one mongoose have been killed. Plate 7 shows a mongoose that was caught at water Unit 18 after killing two quail.

The New York type pheasant trap constructed of number 14 guage welded wire with a one by two inch mesh (Plate 8), and a variation of the clover leaf type are being used to trap pheasants. (Plate 9). The traps are located on the Parker Ranch land in the Waikii area. Two traps are placed at the edge of a three hundred acre cornfield (Plate 8) where there is a high concentration of pheasants. Two other traps are located in typical pheasant habitat in the pasture land (Plate 10). Scratch feed and water are used as bait. It apparently takes longer for pheasants to become used to the food and traps. To date only two pheasants have been trapped, however, the trapping will be continued throughout the year.

TABLE I

BROOD OBSERVATIONS IN WAIKII AREA FOR LAST WEEK OF JUNE AND FIRST WEEK OF JULY 1949

Location	Cock	Hen	Ratio	Young	Adult Young Ratio	Hens w/ Brood	Hens w/o Brood	Brood Size Av.	Brood Age Class I	II	III	IV
Waikii & Area	52	76	1:1.46	91	1:71	31	29	3.16	0	4	12	15
Waikii Pohakuloa	7	12	1:1.71	16	1:84	7	4	2.50	1	4	1	4
Pohakuloa	3	6	1:2	9	1:1	4	2	2.25	0	1	1	3
Kilohana	7	2	1: .28	2	1: .22	1	1	2.00	0	0	0	1
Keamoku	4	3	1: .75	7	1:1	3	0	2.30	0	0	1	2
Puulaau	13	7	1: .54	4	1: .2	1	6	4.00	0	0	0	1
Puu kapele	1	1	1:1	3	1:1.5	1	0	3.00	0	0	1	0
Kaohe	1	1	1:1	0	1:0	0	1	0.00	0	0	0	0
Puu Akala	1	1	1:1	4	1:2	1	0	4.00	1	0	0	0
Waimea Area	4	7	1:1.75	16	1:1.45	3	4	3.00	0	0	0	3
TOTAL	93	116	1:1.24	152	1: .76	52	47	3.0	2	5	16	29

Total Cock: Hen Ratio 1:1.24

Adult: Young Ratio 1:76
% of Hens w/broods 47.5%

Percentage of broods in Age Classes I - 3.8% II - 9.6% III - 30.7% IV - 35.9%

TABLE II

BROOD OBSERVATIONS IN CONNECTION WITH CENSUSING FROM SECOND WEEK IN JULY TO LAST WEEK IN JULY 1949

Location	Cock	Hen	Ratio	Young	Adult Young Ratio	Hens w/ Brood	Hens w/o Brood	Brood Size Av.	Brood Age Class I	II	III	IV
Waikii	13	10	1:.76	5	1:.21	2	8	2.50				2
Around Waikii	37	28	1:.75	25	1:.38	12	17	2.08			3	8
Kapapala	9	7	1:.77	3	1:.18	1	6	3.00				1
Kahua	2	13	1:6.5	22	1:1.4	6	7	3.66			3	3
Below Waimea	6	6	1:1	13	1:11	2	1	6.50				2
Ainahou	2	0	1:0	2	1:1	0	0					1
Horse Paddock		0	1		0	1:.75	0	1				
Pohakuloa	3	1	1:.33	1	1:.25	0	3					1
Between Waikii Pohakuloa	22	3	1:.13	0		0	3					
Above Pohakuloa	5	1	1:.2	0		0	1					
TOTAL	99	70	1:.77	71	1:.42	23	47	3.09			6	18

Total

Cock: Hen Ratio 1:.77

Adult: Young Ratio 1:.42

% of Hens w/broods 32.8%

% of broods in Age Class III - 25% IV - 75%

TABLE III

PHEASANT AND QUAIL DENSITIES OF THE ISLAND OF HAWAII
FOR SCHWARTZ REPORT, 1948 AND 1949

Pheasants per square mile

	1947*	1948	1949	Scrap Values
Waikii	51-100	128	134.2	6
Around Waikii Village	26-50	233	230	11
Kapapala	11-25	8.6	33.5	31
Kahua	1-25	13	18.2	32.4
Below Waimea	1-25	22.4	23.5	19
Ainahou	1-10	—	3.4	5
Horse Pasture	11-25	—	12.2	9
Pohakuloa	1-25	11	30.2	10
Between Waikii and Pohakuloa	51-100	—	40.8	12
Above Puulaau	1-25	—	22.4	4
Puu Anahulu	1-25	16.5	—	7

California Quail per square mile

Pohakuloa	151-300	368	440	10
Between Waikii and Pohakuloa	301-600	326	660	12
Above Puu Laau	16-40	62.8	110	4
Above Umikoa	151-300	283	434	13
Kahua Kai	16-40	40.5	70	6
Ainahou	16-40	—	14.6	5

Japanese Quail per square mile

Waikii	41-75	281	83.5	6
Pohakuloa	—	5.8	39	10
Kapapala	151-300	8	73.1	31
Kahua	16-75	54.4	44	32.4
Below Waimea	41-150	29.3	49.83	19
Above Umikoa	—	—	25.1	13
Between Waikii and Pohakuloa	41-75	85	3.2	12

*From Schwartz Report - 1947

TABLE IV - MAUI

Pheasants per square mile

Area	1947*	1948	1949	Strip Miles
Kahakuloa	11-25	5 seen	1 seen	
Puu Nianiau	51-100	93	138.5	20
Kula	26-50	55.5	13	31
Kula-Makawao	26-50	37.1	32.4	31
Hana	26-50	14	less than 10	29
Ulupalakua	26-50	36.2	22.1	19
Above Kula	26-50	40.7	37.25	21
Waikapu	11-25	—	—	10
Hanakohau	11-25	—	—	5

California Quail per square mile

Puu Nianiau	1-15	—	27	20
Above Kula	41-75	123	49.57	21
Kula	1-15	73	83.5	31

Japanese Quail per square mile

Puu Nianiau	41-150	38.4	14.6	20
Ulupalakua	151-300	47.1	69.8	19
Kula	151-300	43.6	—	31
Kula-Makawao	151-300	15	—	31

LANAI

Pheasants per square mile

Edge of Pineapple Fields	11-25	—	107.18	12

Japanese Quail per square mile

Edge of Pineapple Fields	41-75	—	65.81	12

MOLOKAI

California Quail per square mile

		May 1949	Aug. 1949	
Kaunakakai	41-75	368	504	5

*From Schwartz report - 1947

TABLE V

PHEASANT DENSITIES ON OAHU AND KAUAI FOR 1947 AND 1949

OAHU

Area	1947*	1949
Above Maunalua	26-50	6
Above Kahuku	26-50	4

KAUAI

Above Kekaha	51-100	20
Kilohana	11-25	48
Above Wailua	11-25	63

*From Schwartz Report - 1947

TABLE VI

TRAPPING DATA ON CALIFORNIA QUAIL IN THE POHAKULOA GAME MANAGEMENT AREA ON HAWAII

Location	Quail Banded	Male	Female	Adult	Young
Nene Pen	45	35	10	12	33
Horse Paddock	35	21	14	14	21
Water Unit No. 2	28	18	10	8	20
Water Unit No. 19	17	11	6	6	11
J-3	22	12	10	9	13
Water Unit No. 18	19	10	9	7	12
Cornfield*	4	3	1	0	4
TOTALS	170	110	60	56	114

Cock: Hen ratio = 1: .54

Adult: Young Ratio = 1: .49

*Four quail caught in pheasant trap at cornfield in Waikii.

LACE-NECKED DOVE STUDIES

The press of other duties prevented the leader of this section from obtaining as much data on the breeding season of doves as was desired.

Two visits were made to the Kawaihai dove pass on Hawaii in August. 18 lace-necked doves were collected from that location on August 11. All were examined for the presence of tapeworms. Of the 18 examined, only 3 or 16.6% contained tapeworms.

Four lace-necked doves were trapped on Oahu and they are being retained alive in the laboratory for experimental purposes. The fourth dove so trapped was sacrificed and was found free of parasites.

Four doves were collected on Maui and all contained tapeworms. One dove shot on Lanai contained tapeworms also.

A recent communication from Mr. Charles W. Schwartz contained information to the effect that tapeworms collected from lace-necked doves in Hawaii had been sent to Dr. Don Coburn, Patuxent Research Refuge, for indentification. Word concerning the identification is expected soon. Mr. Schwartz also stated that no tapeworms were found in the lace-necked doves collected on Maui during the course of his survey work.

It is planned to examine doves obtained by hunters during the November-December hunting season. Data such as age, sex and weights will be obtained and wherever entrails can be taken, this will be done in connection with the parasite study.

SUBMITTED BY: _____

R. J. Woodworth
Wildlife Biologist

PROJECT NO. FR. 4K.

DATE October 1, 1949 to

[illegible] 1, 1950

VOL. I NO. 2

PROGRESS REPORT
SURVEYS AND INVESTIGATIONS
as required by
FEDERAL AID IN WILDLIFE RESTORATION ACT

1. Title of Project: Pheasant, Quail and Deer-related Range Studies
2. Leaders: John R. Woodworth and J. Donald Smith
3. Report of Progress:

The trapping and banding of ring-necked pheasants and California Valley quail on the Tehama-Colusa Game Management Area and the Parker Ranch was the principal activity during the month of October, 1949. Weights of the quail trapped were taken from October 24 to October 31, 1949.

The same procedure that was described in the previous quarterly report was used. Small California-type quail traps and modifications of the type described by Stoddard which are constructed of both half inch and quarter inch hardware cloth were used. Pheasant traps of the New York type constructed of number fourteen gauge welded wire with a one by two inch mesh, and a variation of the clover leaf type were used.

The traps operating to date have been located at the areas indicated on Map I. An additional 31 California Valley quail were trapped during the month of October, bringing the total up to 233.

The data concerning the California Valley quail are presented in Table I. The young:adult ratio indicates that there are only one-third more

limiting factor must be holding down reproduction. This is some-
[illegible] gathered at the hunter checking
station in November and December, 1949. Table VI gives the average weights
of quail trapped the last week in October.

Pheasant trapping has been continued throughout the season;
very little attention was given to trapping during the month of
[illegible]

Fifteen pheasants have been trapped to date, the locations of
which that have been successful are shown on Maps I and II. Data
concerning the pheasants are presented in Table III. Pheasants are
readily the first day it is scattered, however, very few will enter
the traps. As many as fourteen traps have been in operation at one time
and pheasants have visited each of these traps in one day. They will eat
[illegible] and [illegible]
corn. Wash water and decoys have also been used as bait; however, neither
of these proved to be successful. The decoys failed because they were destroyed
by mongooses soon after being placed in the traps. A new type of snare trap
will be tried which holds the snared birds by the foot. Quail, on the other
hand, are slow to take the bait, often passing by it for two or three weeks.
However, once they start taking the scratch feed, most of the covey will enter
the traps.

The principal activity during the month of November was confined
to the operation of the hunter checking stations. One was located in the
Waikii area of the Parker Ranch on the Island of Hawaii and the other at
the Pohakuloa Game Management Area also on Hawaii.

Hunting by permit for ring-necked pheasants and California Valley

quail was allowed on the Parker Ranch on weekends and legal holidays during the month of November. Hunting by permit for ring-necked pheasants and California Valley quail is being permitted on the Pohakuloa Game Management Area from November 1, 1949, to January 31, 1950, on weekends and legal holidays.

DESCRIPTION OF HUNTING AREAS

The Parker Ranch opens an area in the Waikii section which is located about 50 miles west of Hilo. The area open to hunting is shown on Map II. This section is used principally for grazing horses and cattle with the exception of a three hundred acre cornfield at the Waikii village. (PlateII). A variety of cover and food types are found the majority of which are excellent pheasant habitat. The rolling country is covered largely by bunchgrasses such as (Eragrostis grandis), clover (Trifolium repens), wild oats (Avena fatua L.), and rat tail or smut grass (Sporobolis capensis). Plate III shows the typical area that was opened to hunting. The small hills or puus are usually covered with aalii and ilima which offer excellent cover where the pheasants hide after the shooting starts.

The Pohakuloa Game Management Area is located in the saddle between Mauna Loa and Mauna Kea about 35 miles west of Hilo. It comprises about 10,000 acres of hunting area which was considered waste land until taken over as a game management area. The area open to hunting is shown on Map I. It is very dry and arid with about 8 inches annual rainfall. The west half is covered with pili grass (Heteropogon contortus) and (Chenopodium oahuensi) with a few scattered mamani (Sophora chrysophylla) and naio (Myoporum sandwicense) trees. (Plate IV). The eastern half of the area has a very dense stand of mamani trees with occasional patches of bunch grass and pili grass. (Plate V). Game bird watering devices of the catchment

and vacuum type have been installed throughout the area under Federal aid project 1-D.

The objectives of the checking stations were to obtain: (1) information on hunting pressure and hunting success (2) adult:young ratio of birds killed (3) data for calculating total populations (4) total kill.

HUNTER CHECKING PROCEDURE

The data presented in this report is based primarily on information obtained during the hunting season in 1949. On the Parker Ranch, daily shooting was stopped at 4:00 p.m. A daily bag limit of three cock pheasants and fifteen California Valley quail was enforced throughout the season. On the Pohakuloa area hunting was allowed from one half hour before sunrise until one half hour after sunset. The bag limit was the same as on the Parker Ranch.

All hunters were required to check in at checking station before going into the field and to check out again when they were finished hunting for the day. (Plate VI). Each hunter was asked to have the birds he had killed examined by game technicians and to fill out a small questionnaire giving the information concerning number of birds killed, crippled, area hunted, and whether or not a dog was used. (Plate VII). The hunters proved to be very cooperative at both checking stations with extremely few violations of the rules set up by the Ranch and the Territorial Division of Fish and Game.

During the hunting season the Parker Ranch and the Pohakuloa Game Management Area were posted with signs showing restricted areas and advising hunters that the area was open to hunting by permit. When the

hunters checked in, each hunter was given a map of the area Map I and II and informed that he must check in before leaving.

CHECKOUT RESULTS AT PARKER RANCH

Table IV shows the weekly statistics for pheasants killed on the Parker Ranch during the month of November, 1949.

Hunter Pressure

The hunting pressure remained almost constant because the Parker Ranch permitted only a limited number of hunters per day. The area open to hunting contained approximately 30,000 acres. An average of 60.5 persons hunted each day which allowed each hunter approximately 497 acres in which to hunt.

Birds Per Hunter

The hunter success figures show a gradual decline as the season progressed. Since the area open to hunting represented a very small portion of the Ranch, it is possible that many of the birds left the open area to remain in the restricted section after the shooting started.

One of the principal objectives of the pheasant banding program on the Parker Ranch is to determine the movement of birds. We hope it will be possible to tell whether or not the pheasants will move far enough to go from the open area to the restricted zone for protection.

Gun Hours

Table V gives the gun hour data for the Parker Ranch. This table indicates that the number of gun hours it took to bag a bird gradually increased, while the gun hours per man remained fairly constant. (Figure I). This would suggest that the steady drop in average birds per hunter may be due to the fact that the birds were getting scarce or moving out of the open area into the refuge.

Adult:Young Ratio of Kill

The method employed in aging the pheasants was by probing the bursa of fabricius to determine its depth. Only the birds that reached the checking station undressed were considered. Those that had been dressed often had the bursa cut away. Since very little work has been done on aging birds in Hawaii and birds with a bursa depth of 6--10 millimeters are usually considered questionable in the mainland, the birds with a bursa length under ten millimeters were considered adults. Those over 10 millimeters were considered young of the year. Table IV gives the number of young and adult pheasants by weekly periods. The ratio is almost 1:1. This indicates very poor reproduction for the 1949 season. This information corresponds favorably with the information obtained in brood survival studies conducted in June, 1949, which showed that only 47.5% of the hens that were seen had broods and those that had broods averaged only three per brood.

Weights

Birds were weighed on a spring scale and weights were recorded as accurately as possible. Table IV shows the average weekly live weights of young and adult birds. The adult cock's average weight of 2 pounds 11.4 ounces is lightly higher than the average weight of 2 pounds 11 ounces for cock pheasants in the Sacramento valley in California in 1946, 1947 and 1948. It is interesting to note the steady increase in weight as the season progressed. Also it shows that the young birds appear to gain weight faster than the adults. The heaviest undressed bird brought in weighed 3 pounds 5 ounces. Many large birds were brought in dressed. Some of these would have weighed more but only live weights were considered in this study.

Cripples

Table IV gives the number of birds crippled each weekend of

hunting. An overall crippling loss of 14% resulted. This loss would have been much greater except that about 85% of the hunters used dogs.

Quail Taken

Eighty-four quail were shot on the Parker Ranch in November. Thirty were young birds and fifty-four were adults. This young:adult ratio further indicates poor reproduction for the 1949 season.

CHECKOUT RESULTS

Table VI shows the weekly statistics for California Valley quail and pheasants killed on the Pohakuloa Game Management Area during November and December, 1949. Table VII is a comparison between the statistics gathered in 1948 and 1949.

Hunting Pressure

The hunting pressure gradually decreased as the season progressed until December 3 and 4. This is in contrast with the pressure on the Parker Ranch because permission was granted to anyone that applied for a permit at Pohakuloa whereas the Ranch had a limited quota for each hunting day.

Birds Per Hunter

The average number of birds per hunter also shows a gradual decrease until December 3 and 4. Since that weekend not enough people have hunted to give accurate results hence a great fluctuation in averages. The taking of pheasants is more or less incidental since the principal game hunted is quail.

Gun Hours

Table VIII gives the gun hours for the Pohakuloa area based on weekends of hunting. The table indicates that the gun hours per man were fairly constant; however, the gun hours per bird follows no definite pattern. (Figure II). There appears to be an increase in gun hours per bird until

December 3 and 4 after which no definite trend is noticeable. This can possibly be attributed to the ability of the hunters. When a small number of persons hunt and two or three of them are experts who can shoot four or five quail in a few hours, the average quail per hunter is increased considerably. For instance, on December 3 and 4 five hunters shot 21 of the 22 quail that were taken. Had all of the hunters been inexperienced, the average may have been as low as the weekend before.

Adult:young Ratio of Kill

The method employed in aging the quail was by examination of the primary coverts. Table VI gives the number of young and adults by weekly periods. The average ratio is almost 1:1 and an examination of the sex ratios shows that there were only 1.8 young for every adult female that was examined. This information indicates poor reproduction success last spring and further substantiates the information mentioned earlier in the report.

Weights

Quail were weighed on a spring scale and weights were measured to the nearest gram. Table IX gives the weekly average weights and the total average for the season to date. The normal differences are shown with the females slightly lower than the males and the young birds weighing a little less than the adults.

Population Calculations

Eight of the 203 quail killed were banded birds. By using the formula

$$\frac{\text{Banded Birds Killed}}{\text{Total Birds Banded}} = \frac{\text{Unbanded Birds Killed}}{\text{Total Population}}$$

a fairly accurate estimate of the population present on the area can be determined. Two hundred and thirty one (231) quail have been banded to date. By substituting the available figures in the formula, we get a

population of 5,861 quail on the area. This figure is slightly less than the estimate (6-7000) obtained by censusing in July, 1949.

It appears that the low average of quail per hunter is not due to a scarcity of birds on the area. Most of the hunters questioned estimated that they had seen between fifty and one hundred and fifty quail while they were hunting. Most of the hunters are inexperienced quail shooters and the large dense mamani tress make shooting difficult. Many hunters have reported getting five to ten shots without killing a bird.

Conclusions

In view of the foregoing data, it seems likely to assume that there was some limiting factor or combination of factors causing poor reproduction of both pheasants and quail on the Parker Ranch and the Pohakuloa Game Management Area during the 1949 season. Since practically no work has been done on reproductive success in Hawaii, it is impossible to draw any definite conclusions at this time. It is possible that the extremely dry 1949 spring and summer could have affected the reproduction. Also an abundance of feral pigs, feral cats, and mongooses are present on the area. Anyone of these animals could cause severe predation during the nesting and hatching season or a combination of all of the factors may be the cause of the apparent low reproduction; however, there is no apparent reason why predators should be more of a limiting factor in 1949 than any other season. An intensive study during the breeding and nesting season will be conducted this spring to try to determine what the cause or causes may be.

TRAPPING DATA ON CALIFORNIA VALLEY QUAIL IN THE POHAKULOA GAME MANAGEMENT AREA ON HAWAII

Location	Quail Banded	Male	Female	Adult	Young
Nene Pen	51	37	14	16	35
Horse Paddock	36	21	15	15	21
Water Unit No. 2	31	18	13	11	20
Water Unit No. 18	46	26	20	29	17
Water Unit No. 19	17	11	6	6	11
Water Unit No. 8	2	1	1	2	0
J-3	23	12	11	10	13
X-1	23	10	13	11	12
Cornfield	4	3	1	0	4
	233	139	94	100	133

TABLE II

AVERAGE CALIFORNIA VALLEY QUAIL WEIGHTS TAKEN FROM TRAPS THE LAST WEEK IN OCTOBER (IN GRAMS)

Adult Male	Adult Female	Young Male	Young Female
182	170	168	167

TABLE III

TRAPPING DATA ON PHEASANTS IN THE POHAKULOA GAME MANAGEMENT AREA AND THE PARKER RANCH ON HAWAII

Location	Pheasants Banded	Male	Female
Cornfield	5	1	4
Cattle Guard	2	1	1
X-2	3	0	3
X-3	1	0	1
No. 6	1	1	0
No. 7	1	0	1
No. 24	2	2	0
Total	15	5	10

Date	No. Hunters	Measured Hours	Aver. No. per Hunter	Squadron	Young Birds	White Birds	Average Live Wt. Young
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	111	267	2.04	42	123	139	2#7.4 oz. 2#10.[illegible] oz.
[illegible]	[illegible]	294	1.57	27	107	118	2#5.6 oz. 2#11.[illegible] oz.
[illegible]	[illegible]	194	1.56	30	70	71	2#9.2 oz. 2#13.8 oz.
[illegible]	[illegible]	207	1.25	37	88	72	2#9.7 oz. 2#[illegible].9 oz.
Total	605	963	1.53	136	393	400	2#8.7 oz. 2#11.4 oz.

TABLE V

GUN HOUR DATA FOR THE MONTH OF NOVEMBER
ON THE PARKER RANCH

Average Bag	1	2	3	4	5	6	7	8	9	10	Average
[illegible]	6.6	6.1	6.3	7.2	7.2	6.6	5.1	6.6	6.9	[illegible].5	6.5
[illegible] per Hour	3.0	3.4	3.1	5.0	5.1	4.2	3.3	4.0	6.4	[illegible].3	4.1
[illegible]	[illegible]	410	353	439.5	475	378	336.5	361	339	401	394

TABLE VI

[illegible] DATA ON CALIFORNIA QUAIL AND PHEASANTS
TAKEN ON THE POHAKULOA GAME MANAGEMENT AREA

Areas	Hunters	No. of Quail	Aver. per Hunter	Young	Adult	Unknown
Sec. 3, 4	17	79	.67	39	40	4
11, 12, 13	[illegible]	54	.57	17	37	5
[illegible] 25	[illegible]	16	.49	11	5	4
24, 25, 2[illegible]	[illegible]	5	.19	2	3	2
Sec. 2, 4	11	22	2.00	12	10	2
10, 11	11	7	.50	6	1	0
17, 18	12	12	1.00	8	4	2

Weekend	Hunters	No. of Quail	Aver. per Hunter	Young	Adult	Percentage
24, 26	1	4	4.00	4	0	1
31, Jan. 1	8	4	.50	4	0	2
Total	317	203	.64	103	100	26

TABLE VII

A COMPARISON OF STATISTICS GATHERED IN 1948 AND 1949 ON CALIFORNIA VALLEY QUAIL IN THE POHAKULOA GAME MANAGEMENT AREA

	1948	1949
Total Birds Shot	239	203
Total Hunters	230	317
Average Bag per Hunter	1.4	.64
Gun Hours per Quail	4.1	8.8
Percentage of Hunters Using Dogs	18%	38.2%
Average Bag of Hunter with Dog	1.5	.76
Percentage of Hunters Not Using Dogs	81.3%	61.7%
Average Bag of Hunters Not Using Dogs	.90	.52
Percentage of Unsuccessful Hunters Using Dogs	51.1%	57.3%
Percentage of Successful Hunters Not Using Dogs	63.6%	67.7%
Crippling Percentage for Hunters Using Dogs	15%	13.7%
Crippling Percentage for Hunters Not Using Dogs	15.3%	11.6%
Crippling percentage for All Hunters	15%	12.4%

TABLE VIII

GUN HOUR DATA FOR MONTHS OF NOVEMBER AND DECEMBER ON THE POHAKULOA GAME MANAGEMENT AREA

Hunting Weekends	1	2	3	4	5	6	7	8	9	Average
Gun Hours Per Man	5.4	7.1	6.2	3.6	4.2	4.0	5.2	4.5	5.8	5.6
Gun Hours Per Bird	7.8	11.7	11.6	18	2.6	8.0	5.2	1.1	11.6	8.8
Total Gun Hours	613	640.5	186	90	59.5	56.5	63	4.5	46.5	199.9

TABLE IX

AVERAGE WEEKLY WEIGHTS IN GRAMS

Weekend	Male Young	Female Young	Male Adult	Female Adult
Nov. 5, 6	168	164	173	165
11, 12, 13	170	165	171	165
19, 20	169	170	192	—
24, 26, 27	—	168	178	180
Dec. 3, 4	181	157	170	181
10, 11	182	—	186	168
17, 18	168	156	179	166
24, 26	—	—	182	180
31, Jan. 1	—	—	180	165
Total	170	164	176	168

STATE Territory of Hawaii

PROJECT NO. PR. 5R1

DATE January 1, 1950 to
March 31, 1950

VOL. I NO. 3

PROGRESS REPORT
SURVEYS AND INVESTIGATIONS
as required by
FEDERAL AID IN WILDLIFE RESTORATION ACT

1. Title of Project: Pheasant, Quail and Lace-necked Dove Studies

2. Leaders: John R. Woodworth and J. Donald Smith

3. Report of Progress:

The principal activity during the month of January was the continued operation of a hunter checking station on the Pohakuloa game management area. January 30, 1950 concluded a three months open season on California valley quail during weekends and legal holidays. The ring-necked pheasant season closed on January 15, 1950.

CHECKOUT RESULTS AT POHAKULOA

Table I gives the data obtained at the Pohakuloa checking station during January and the grand total for the entire season. The data concerning the two previous months were included in the preceding quarterly report.

Hunting Pressure

The hunting pressure remained comparatively low the last month of the season averaging only 8.8 hunters per weekend. This was approximately the same as for the month of December.

Birds Per Hunter

The average number of birds per hunter was considerably lower in January than for the two previous months which averaged .64 quail per hunter; however, there were not enough hunters participating to appreciably change the overall average for the season. The considerable fluctuation in weekly averages can probably be attributed to not having a large enough sample to give reliable results.

Gun Hours

Table II gives the gun hour data for the Pohakuloa area during the month of January based on weekends of hunting. The average is the grand total for the three month season. The table indicates the gun hours per man to be fairly constant as they were in November and December; however, the gun hours per bird show no definite pattern. This can possibly be attributed to the ability of different hunters plus the small size of the sample. Observations indicate that the post season population of quail is quite high; hence, it is difficult to understand the high number of gun hours per bird.

Adult:Young Ratio of Kill

The method employed in aging quail was by examination of the primary coverts. Table I gives the number of young and adults by weekly periods. The ratio for January is about what one would expect under normal conditions; however, the grand total ratio remains close to 1:1 and an examination of the sex ratios shows that there were only 1.9 young for each adult hen. This information is indicative of poor survival of birds hatched last spring.

Weights

Quail were weighed on a spring scale and weights were measured to

the nearest gram. Table III gives the weekly average weights for the month of January and the total average weights for the season. Twenty quail weights were averaged for the January averages and 219 weights were taken for the seasonal average.

Population Calculations

A population of 5831 California valley quail was calculated for the Pohakuloa area by using the following formula:

$$\frac{\text{Banded Birds Killed}}{\text{Total Birds Banded}} = \frac{\text{Unbanded Birds Killed}}{\text{Total Population}}$$

Eight bands were returned by the hunters this season and a total of 233 quail were trapped and banded; however, twenty of these were killed by predators which left only 213 available to the hunters. This calculated population is slightly under the estimate of 6-7,000 made during the July strip census in 1949.

Pheasants Taken on Pohakuloa

A total of thirty-one cock pheasants were taken by hunters on the Pohakuloa area. These figures are encouraging in view of the fact that most of the hunters predicted that there would be less than twenty cocks killed on the area. The average weight of the cocks killed was 2 pounds 12 ounces. This is slightly higher than the weights of adult cocks killed at Waikii in November. From sight records obtained during trapping operations in January and February, there appears to be a definite increase in the pheasant population on the Pohakuloa area. Crowing counts made recently further indicate a uniform population of cock pheasants throughout the area. This increase might be due to the feed that has been put out to lure pheasants into traps or to the more abundant rainfall occurring during the last few months.

Conclusions

Since the data for the month of January on the checking station at

Pohakuloa did not change the overall picture to any noticeable extent, it seems proper to assume the same conclusion that was presented in the last quarterly report--there was definitely some limiting factor or combination of factors causing poor reproduction of quail on the Pohakuloa game management area during the 1949 season. A nesting study has been started in both the Pohakuloa area and the Waikii area which it is hoped will give some indication as to the cause of this apparently poor production and survival of young birds. It is too early to expect any significant results from this study.

TRAPPING AND BANDING CALIFORNIA VALLEY QUAIL

The principal activity during February was the trapping and banding of California valley quail on the Pohakuloa game management area. The same procedure that was described in the previous quarterly reports was used. Small California-type quail traps and modifications of the type described by Stoddard which are constructed of half inch and quarter inch hardware cloth were used.

The traps operating to date are located on map I. An additional 37 quail have been trapped and banded bringing the total up to 270.

The data concerning the California valley quail for the month of February and the grand total are presented in table IV. The February results show an extremely heavy adult population which brings the grand total adult-young ratio to almost 1:1. According to the available figures, each adult hen produced slightly less than two young for the last season. Ordinarily one would expect five or six young for each adult hen. This adult-young ratio which tends to indicate that there was extremely poor survival of the young birds that hatched last spring.

BREEDING AND NESTING STUDIES

Numerous cock pheasants and quail were seen and heard crowing throughout the range during the month of February. This plus an advanced development of the gonads of birds collected at that time indicated that the breeding season for ring-necked pheasants and California valley quail was approaching. Job outlines dealing with a "pheasant crowing count census" and a "nesting study" were prepared and are included in this report.

The month of March was devoted to cruising the pheasant and quail ranges in the Pohakuloa and Waikii areas on the island of Hawaii. Trained bird dogs were used to locate as many birds as possible so that a post season sex ratio could be obtained. Some five hundred pheasants were flushed in the areas that were hunted last fall and the sex ratio proved to be 1:1.

Crowing counts were started on the island of Hawaii on February 28, 1950. The sample taken to date is not large enough to be significant; however, in the Pohakuloa area the average number of calls heard in a two minute period at sunrise is 11.5 while in the high density area around Waikii the average number of calls heard is 45.7.

Trained bird dogs are also being used to locate pheasant and quail nests. Nine pheasant nests and one quail nest were found the last week in March. The quail hen was setting and had thirteen eggs in her nest, while the two highest counts for pheasant clutches were 14 and 16. Six eggs were taken from the nest of a hen pheasant that was accidentally killed. These eggs will be placed under a domestic hen and if they hatch successfully, the chicks will be used as control birds to estimate the age of various broods observed in the field. The chicks will also be used to determine bursal depths at various ages.

Submitted:

Name J. R. Woodworth

Title Game Biologist

Approved by:

Division of Fish and Game

By Vernon E. Brock

Title Director

Date April 19, 1950

TABLE I

WEEKLY DATA ON CALIFORNIA VALLEY QUAIL AND RING-NECKED PHEASANTS TAKEN ON THE POHAKULOA GAME MANAGEMENT AREA DURING JANUARY, 1950

Weekend	Hunters	No. of Quail	Aver. per Hunter	Young	Adult	No. of Pheasants
Dec. 31, Jan. 1, 2	8	4	.50	4	0	2
Jan. 7, 8	12	0	.00	0	0	3
Jan. 14, 15	15	7	.46	5	2	2
Jan. 21, 22	2	5	2.50	4	1	
Jan. 28, 29, 30	7	4	.57	2	2	
Total for January	44	20	.45	15	5	7
Total for Season	353	219	.62	114	105	31

TABLE II

GUN HOUR DATA FOR THE MONTH OF JANUARY ON THE POHAKULOA GAME MANAGEMENT AREA

Hunting Weekends	9	10	11	12	13	Total Seasonal Average
Gun Hours Per Man	5.8	4.9	4.8	6	6.6	5.25
Gun Hours Per Bird	11.6	5.9	10.2	3	11.6	8.33
Total Gun Hours	46.5	59	71.5	12	46.5	149.88

TABLE III

AVERAGE WEIGHTS IN GRAMS OF CALIFORNIA VALLEY QUAIL TAKEN AT POHAKULOA IN JANUARY, 1950

Weekend	Young Female	Young Male	Adult Female	Adult Male
Dec. 31, Jan. 1, 2	—	—	165	180
Jan. 7, 8	—	—	—	—
Jan. 14, 15	160	180	—	180
Jan. 21, 22	170	181	—	187
Jan. 28, 29, 30	164	—	—	190
Season Total	164	171	168	176

TABLE IV

TRAPPING DATA ON CALIFORNIA VALLEY QUAIL IN THE POHAKULOA GAME MANAGEMENT AREA ON HAWAII

Area	No. of Quail banded	Male	Female	Adult	Young
Water tank	31	17	14	29	2
No. 15	2	1	1	1	1
No. 18	3	2	1	1	2
X-1a	1	1	0	1	0
Total	37	21	16	32	5
Grand Total	270	160	110	132	138

JOB OUTLINE

SURVEYS AND INVESTIGATIONS PROJECTS

Project No. 5 - R - 1 Work Plan No. 1 Job No. 6

Title of Job: Crowing Count Pheasant Census

Objectives: The purposes of this job are as follows:

1. To obtain a population index for pheasant ranges on Hawaii and other islands
2. To determine trends of game bird populations on management areas
3. To determine what time of the year to conduct the annual roadside surveys and censuses

Procedure: The following methods and techniques will be used:

1. A representative 15 or 20 mile route will be located through the area to be censused. More routes can be established if time and roads are available. These routes should be located where winds are generally below eight miles per hour at sunrise, and where there are few telephone wires which make a distracting hum in light wind.
2. The count will be made from an automobile. In making the run, the following procedure will be used; stop the car, shut off the motor, get out and walk at least 15 feet away, stand perfectly still and count cock calls for exactly two minutes. (Only the regular two-syllable crowing of cock pheasants should be counted.) Get back in the car, record the count, drive exactly one mile and repeat the same procedure. This will be continued for as many miles as there are in the route. The run should be completed as quickly as possible.

3. The time of day to start the run in to begin approximately 30 or 40 minutes before sunrise, and it should be completed by 50 minutes after sunrise if possible. The wind is at a minimum and the crowing at a maximum at this time.

4. One or two check routes will be established to determine when maximum crowing occurs so that the dates between which regular census routes can be run can be determined. The check routes should be run twice weekly until censusing starts. Roadside crowing counts should be conducted at a definite number of days following the time when seasonal crowing activity reaches near maximum and levels off. This should greatly reduce the variable factor which introduces the greatest error in all types of roadside surveys; that is, the factor of not conducting the survey at exactly the same point in the reproductive cycle of the pheasant each year.

5. Compilation of the data after the field work has been completed provides an index to the spring cock population. This index in itself has considerable value but it also serves as a basis for determining other population characteristics through application of ratios. The following formulas show the derivation of total population indices at two times of the year.

$P = C + C H$

$P = C + C H + C H Y = C(H + H Y + 1)$

p = Spring breeding population index

P = Post-breeding population index

C = Cock calls per two minutes

H = Hens per cock

Y = Young per hen

the application of the above formulas may not be possible at this time because of insufficient data; however, it will be applicable during future seasons.

5. Whenever possible mass trapping programs of individual coons will be made to determine the degree of variation, if any, due to weather conditions, different population densities, varying sex ratios or mated and unmated coons.

Work Schedule: Approximate beginning date: January 21, 1951

Approximate closing date: May 31, 1950

Location of Work: Stands on Wildlife Restoration sections or Special Areas as suitable pheasant range; on other islands as personnel and time permits.

Work Assigned to: John R. Woodworth, project leader

J. Donald Smith, project leader (as other work permits)

Prepared by John R. Woodworth
John R. Woodworth
Wildlife Conservationist

Approved by J. D. Smith

Project: [illegible] Work Plan No. 1. Job No. 3

Title: Nesting and Brood Studies of Individual Upland Game Birds

Objectives: The purposes of this job are as follows:

1. To determine the period, degree, and cause of juvenile mortality
2. To determine the dates of maximum period of nesting
3. To determine the extent of re-nesting after destruction
4. To determine comparative nesting success, fertility, renesting, etc., between first nestings and re-nesting
5. To determine the movements of hens and broods
6. To determine clutch size, hatching success, egg fertility, embryo mortality, agents of nest destruction and the amount of nest desertion

Procedure: The work will involve the following methods:

1. Areas where crowing cocks were seen will be marked as possible locations for future nests
2. A trained bird dog will be used in locating nests. When a nest is located it will be marked carefully by a tag on a stake or a notch near the nest
3. Nest locations will be confined to areas where subsequent observation can be conducted with a minimum of effort and time. Where possible nests will be marked along routes to be used for sight records
4. When possible individual hens will be marked by spraying with a saturated solution of picric acid in ethyl alcohol,

using a syringe or other spraying device

5. Complete notes will be kept on the exact location and history of each nest, and on the pattern of each hen that is marked
6. Observations will begin as soon as nests are located and will be made at least once a week, and preferably more often. Observations should be made in the morning and evening, both at close range and at a distance with glasses
7. Data to be recorded on observations of nests and marked birds are: time, date, exact location, cover type, distance from nest, association with other birds and size and age of broods
8. The accompanying form is to be used for nest data and observations

Explanation of Nest and Brood Data Form

County:	Self-explanatory
Observer:	Ditto
No.:	Ditto
Cover type:	Weeds, grass, mixed, etc.
Details of location:	Note proximity to roadway, stream or other cultural or topographical feature to aid in relocation of nest and possible positional effect upon nest destruction

Record of Observations:

Nest discovered:	Note date and number of eggs in nest. In the notes column record time of day and whether or not hen was on nest for the initial and subsequent observations of the nest prior to hatching
Associated birds:	Record number and sex of adult pheasants observed with marked hen

Subsequent Nest Observation: (See Nest discovered). If nest has hatched between nest observations indicate same in Notes column.

Nest hatched: Date of hatch will be an approximate and determined by estimating age of resulting brood or interpolation between visits to the nest. In the Notes column record number of eggs hatched and unhatched and probable cause of failure in regard to unhatched eggs. (Infertility, embryo mortality, predation (by what), flooding, disturbance, farm machinery, etc.).

First Brood Observation: Record date of observation and number of juveniles in brood. In Notes column record distance brood had traveled from nest site and estimated age of brood.

Subsequent Brood Observation: Each time the nesting site or vicinity is visited for express purpose of observing the estimated age of brood if observed, and distance brood has travelled from nest site (in Notes). Record the visit to nesting site or vicinity even if marked hen is not seen.

Remarks: Any general information not included in above

Work Schedule: Approximate beginning date: March 1, 1950

Approximate closing date: August 1, 1950

Location of work: [illegible] area of Hawaii

Work Assigned to: John R. Woodworth, Project Leader

Prepared by John R. Woodworth Approved by [illegible]

John R. Woodworth
Wildlife Conservationist

February 28, 1950

STATE Territory of Hawaii

PROJECT NO. PR. 5R1

DATE April 1, 1950 to June 30, 1950

VOL. I NO. 4

PROGRESS REPORT
SURVEYS AND INVESTIGATIONS
as required by
FEDERAL AID IN WILDLIFE RESTORATION ACT

1. Title of Project: Pheasant, Quail and Lace-necked Dove Studies
2. Leaders: John H. Woodworth and J. Donald Helm
3. Report of Progress:

PHEASANT NESTING STUDY ON HAWAII

Studies of hunters' bags made last fall indicated that there was a very poor survival of young birds hatched during the spring prior to the hunting season. This study was designed to help determine what cause or causes contributed to the low reproduction of the ring-necked pheasant on Hawaii.

Three study areas were established in the area on Hawaii where most of the hunting is done and where the highest populations of pheasants are found. The areas represent three different types of cover in a fairly small area. None of the areas was covered completely with the exception of the cornfield. No boundaries could be established in the other areas. The writer covered as much as

the area as possible in the time allotted for the study.

DESCRIPTION OF THE AREAS

The area chosen for the nesting study is in the vicinity of Waikii, Hawaii, which is a portion of the Parker Ranch located about 50 miles west of Hilo. The location of the nesting areas that were studied is shown in map No. I. Map No. II shows the study areas in relation to the hunting area on the Parker Ranch.

The land use is primarily that of grazing livestock with the exception of a 300 acre cornfield located near Waikii village. Most of the land is covered with grasses and weeds with verbena (Verbena litoralis) and bermuda grass (Cynodon dactylon) being the principal cover in the open pasture land around Waikii which is referred to as the Mauka area in this study (Plate I). In the cornfield which is another study area the principal cover is Rye grass (Lolium multiflorum), brome grass (Bromus catharticus), and bermuda grass (Cynodon dactylon), (Plate II). The third area used in the nesting study is the south eastern portion of Waikii which is referred to as the Puu Laau area. This area is largely covered with a mamani (Sophorus chrysophylla) and naio (Myoporum sandwicense) forest with occasional clearings with verbena (Verbena litoralis), puakeawe (Styphelia tamerameiae), and various grasses. (Plate III).

The topography of the study areas is generally gently rolling foothill country of Mauna Kea. (Plate IV).

PHEASANT POPULATION DENSITY AND SEX RATIO

The abundance of pheasants in the study area is indicated

in Table I. This is an estimate of the spring breeding population based on crowing counts made from March through June. The crowing count figures indicate those made at the height of crowing activity. The sex ratios were obtained just prior to the breeding season. Two well-trained bird dogs were used extensively in the study area and it is believed that the ratios presented are fairly accurate.

METHODS

Nests were located by cruising the areas on foot. Bird dogs were used; however, they proved quite ineffective in locating incubating hens. At first the technician would cruise the areas and search the locations where hens were flushed from nests. This method was very unproductive and two weeks of searching failed to reveal a single nest. Finally close scrutiny of every conceivable nesting place was employed and favorable results were immediate. On May 6, a group of 21 Boy Scouts were used to help the technician locate nests in the 300 acre cornfield at Waikii. The boys would line up abreast with each boy searching down a single row of corn. (Plate V). In about four hours the boys located 34 nests including single eggs which may have been dropped before a nesting site was selected. This method was very successful and will be employed to a much greater extent in the future. At first each nest was marked by a tag on a stake which was driven into the ground near the nest. This method of marking nests proved to be very unsatisfactory. Cattle would find the stakes and chew off the tags then rub against the stakes and trample them into the ground. This made it practically impossible to relocate the nests. The best marking method proved to

be typing a piece of white cloth with the number of the nest on it, to bush or a tree near the nest. Complete notes were kept on each nest and samples of the vegetation were taken from several of the nesting sites that were typical of the area.

An attempt was made to mark incubating hens so that they could be identified at later dates. A saturated solution of picric acid in ethyl alcohol was sprayed on the back and tail of hens while they were on the nests. Seven hens were marked successfully without flushing the hen; however, none of these birds have been seen since the eggs hatched.

An attempt was also made to mark each egg as it was laid in order to determine whether or not there is a correlation between the time of laying and the hatchability. No success was attained in this experiment mainly because no starting nests were located and those that were marked were either destroyed or the hens deserted. The nest and the surrounding vegetation were disturbed as little as possible to minimize the effect of human interference. Each of the nests was visited twice weekly in order to observe the progress of nesting.

NESTING COVER

In the early part of the season the nesting cover consisted largely of dead weeds and grasses. In the Mauka area almost every nest was located at the base of a verbena bush in a clump of bermuda grass. The bermuda grass offered a very soft, springy place to build the nest. Approximately 90% of the nests in the Mauka area were located in this type of cover. In the cornfield,

the nests were located between cornstalks usually at the base of a clump of brome grass and quite often in bermuda grass. (Plate VII). There was no apparent tendency to nest near roadsides or at the edge of fields because the cover was uniform throughout the areas. In the Rau Lean area the preferred nesting site seemed to be at the base of a mawani or naio tree. (Plate VII). On two occasions both California quail and pheasant eggs were found in the same nests. (Plate VII and VIII).

The best cover in the open range-land proved to be areas with a relatively thick stand of verbena and an abundance of bermuda grass underneath. The thick verbena stands appeared to have more nests and less predation. By June most of the areas where the nests were located were covered by an extremely dense stand of brome and rye grass caused by the unusual amount of rainfall in April. This stand of new grass practically obscured the former nesting sites.

OUTCOME OF NESTS LOCATED

A total of 121 nests were located in the three study areas. This number included single eggs some of which were true nesting attempts and others were dropped before a true nesting site was selected. Sixteen of these will be considered dropped eggs. Of the remaining 105 nests, only 13 or 12% were successful. Forty-nine or 46.6% were destroyed, and 43 or 39% were deserted. (Table II). In Table III the data are broken down into active and inactive nests. Active nests are those which are being incubated or eggs are being laid in at the time of discovery.

Inactive nests are those which are either deserted, destroyed, or hatched when discovered.

Out of 105 true nesting attempts (eggs laid in nests), 30 or 28.5% were active and 75 or 71.5% were inactive. When the outcome of the nests are compared, we find the active nests appear to be over twice as successful as the inactive. (Table III). The local ranchers in Hawaii are of the opinion that if nests are disturbed by humans that the mongooses will follow the human tracks to the nest and hence destroy the eggs. From the above findings it appears that this is not true because destruction is about 37% higher in the inactive nests which were not disturbed by humans. Several other workers have found the same to be true in their nesting studies. This may not be a true picture; however, because many of the destroyed nests were easy to find because the eggs had been scattered for some distance around the nesting site. There is a possibility that nests that are easy for a human to find may also be easy for a predator to find. Since this is the first nesting study to be conducted on Hawaii, it will be impossible to determine whether or not the hatch is better or worse than last year's. However, a good check will be the age ratios obtained during the coming hunting season and the population trend obtained from the annual summer census.

A further breakdown of the nesting success produces some interesting differences in fairly adjacent areas. Table II shows the fate of the nests located in the three main areas studied.

The Mauka area (Map I) enjoyed the least amount of

success. The reason is probably two-fold. This writer believes that the mongooses are much thicker in this area accounting for the high percentage of destruction plus the fact that the cover is not as thick as the other areas studied. The cover in this area is largely verbena with an understory of bermuda grass. Many parts of this area have a thinly scattered stand of verbena which offers little protection.

The cornfield appeared to be an ideal nesting area and the success in this area proved to be considerably greater than that in the Mauka area. The cover in the cornfield was dense and uniform (Plate II). In Hawaii farming is of minor importance and the corn is raised only to feed pigs; therefore, little care is given to the field once it is planted. The area is merely plowed and planted with corn then it is left alone until it is harvested. In the meantime an excellent growth of weeds and grasses occurs because of the highly fertile soil. The fact that the cornfield excluded cattle also insured a luxurious growth of cover plants. The increased success can probably be attributed to the excellent cover as well as the apparent lack of mongooses in the area. The greater number of nests found in this area can probably be attributed to two causes. First, it was an easy area to cover thoroughly because each row offered a definite line to walk down. In the other areas there was no way of laying out grids or definite areas to cover. With 2 or 3 thousand acres of uniform habitat in front of one, it offered little chance to cover definite acreages. Secondly, this is where the 21 Boy Scouts were used to assist in locating the

nests. Because of the comparatively small area of the cornfield it is the only area where nesting density could be calculated. Fifty-two nests were found on the approximately 160 acres that were covered for a density of about 1 nest per three acres.

The Puu Laau area proved to have the highest nesting success. This area is largely a mamani (Sophorus chrysophylla) and naio (Myoporum sandwicense) forest with an understory of verbena (Verbena litoralis) and puakeawe (Styphelia tameramiae). (Plate III). The small size of the sample may not give a true picture of the nesting success; however, many large broods were seen in this area and it also proved to have the highest crowing count of any area censused. It is difficult to state why the high success in this area unless the cover offered by the canopy of the forest had something to do with it. The density of mongooses in this area is unknown; however, several have been seen by the writer. Cattle were excluded from most of this area; however, a fairly large number of horses were pastured here.

This study suggests that the pheasants prefer a combination of grass and weedy cover located in the gentle rolling foothills between 3--6000 feet. (Plate IV). The preference for the actual nest site was bermuda grass at the base of a large clump of grass or weeds. The fallow cornfield proved to be preferred over most of the other types of cover.

AVERAGE CLUTCH SIZE

The average size of completed clutches was determined for each area. Only nests that had been incubated were considered

as completed clutches in Table IV. The average clutch size ranged from 12 in the Mauka area to 9.2 in the Puu Laau area. It is not late enough in the season to determine the size of renesting clutches; however, four new nests were reported after mid-June and it is expected that there will be more data available on renesting.

When all nests are considered including deserted nests the average clutch size is considerably larger as shown in Table V with the average clutches ranging from 12.6 in the Mauka area to 9 in the Puu Laau area. The average for the 54 nests considered was 12.2 which is above the average found in most mainland studies.

NEST DESTRUCTION

Nest destruction accounted for 46.6% of all nesting attempts discovered. When one considers that there is no farming in this area, hence no destruction by mechanical means this is extremely high. When broken down into areas the Mauka area is high with 65.8% followed by the cornfield with 36.5% and Puu Laau with 25%. The range in the amount of nest destruction is over 40% between the Mauka and Puu Laau areas. The principal difference in the two areas is that the Puu Laau area is forested while the Mauka section is open pasture land. As mentioned before, a greater abundance of mongooses was noted in the Mauka area than anywhere else. Since there has been very little study made for the mongoose, it is impossible to state why predation should be so devastating in one area and not in another.

It is shown in Table III that the inactive nests suffered

about 37% more loss by destruction than did the active nests.

The causes of nest destruction are somewhat doubtful. However, it is believed that mammals caused all of the destruction except one nest that was run over by an automobile. Cattle accounted for two nests and the remainder, it is believed, was caused by mongoose; thus, 93.8% of the destruction was due to predation. On one occasion a mongoose was caught near a freshly destroyed nest and the contents of the stomach proved to be egg. On several occasions mongoose scats were found near destroyed nests. Almost every destroyed nest looked the same. (Plate IX). The type of egg destruction is shown in Plate X. An experiment is being conducted with trapped mongoose to compare types of egg destruction but no conclusive results have been obtained as yet. The type of destruction closely resembles that caused by the mink. Since the mongoose resembles the mink very closely in form and tooth pattern, it is quite possible that the mongoose is responsible for the greatest amount of nest destruction. Local ranchers have been questioned about destruction, and many of them claim that feral cats will also destroy the eggs. Recently eggs were used as bait and two No. 1 steel traps were placed nearby. A mongoose was caught in one and a feral cat was in the other.

NEST DESERTION

Nest desertion appeared to be extremely high accounting for 39% of all nests discovered. The percentages for areas ranged from 26.8% for the Mauka area to 48% in the cornfield area. (Table II).

A much higher percentage of active nests were deserted than inactive which suggests that human interference does have a significant effect on desertion. Sixteen out of 30 or 53.3% of the active nests found were deserted while only 25 out of 75 or 33.3% of the inactive nests were deserted. (Table III). It is difficult to determine what caused the desertion other than man. Inclement weather and the resulting wet ground during the month of April probably caused a great deal of desertion. It rained almost continually from April 13 until May 4 in all of the study areas. The amount of rainfall for April, 1950, shows 7.94 inches compared with .71 inches in April, 1949. It is quite certain that several nests were flooded on April 22nd and 25th when well over an inch of rain fell in about one hour. Local ranchers think that feral pigs disturb the incubating hens at night and cause them to desert. Disturbance by cattle could very well have an influence in nest desertion. Especially early in the season when stakes were being used to mark nests. Every stake was trampled and broken by cattle. Another factor that causes some desertion is the fact that more than one hen may lay eggs in the same nest. (Plate XII).

FERTILITY AND HATCHABILITY

Only nine hens that were seen incubating produced clutches. Of the 88 eggs laid by these birds only 50 hatched for an average of 56.8%. (Table VI). Both infertility and embryo mortality seem to be unduly high compared with studies made in the mainland. Each of these accounted for 21.6%;

however, infertility was not accurately determined because eggs in which embryo development was not observed were considered infertile although it is possible that some of these may have been fertile. Thus the fertility may be higher than 78.4% shown by these figures. Most of the embryos were fully developed in the eggs that did not hatch. Since the sample is so small, it is doubtful that any differences shown between areas could be considered accurate.

It is possible that there may be a correlation between the hatchability and the climate conditions. Hawaii has extremely wide temperature ranges throughout the year with ranges from 30° F at night to 80° F in the same 24 hour period at elevations of 6,000 feet. This may also be a cause in desertion and the fact that the trees in the Puu Laau area offer shade may be a factor in the apparently higher nesting success in this area.

It is hoped that hygrothermographs will be available next year so that climatic data and soil temperatures can be obtained in the nesting areas.

BROOD DATA

At the time this report is being written the brood study has just begun. To date 52 broods have been seen in the combined areas with an average of 4 per brood. When broken down into separate areas the cornfield has the highest average size brood with 5.7; however, the sample is very small. Puu Laau is second averaging 4 young per brood and the Mauka area is lowest with an average of 3.2 per brood. (Table VII). Three of

the broods recorded were in the Pohakuloa area east of Mauna Loa. The average here is 6 young per brood. It will be possible to determine the nesting peak from the number and age of broods seen during the summer.

A thorough analysis of the brood data will be presented in the following quarterly report.

CROWING COUNT DATA

A crowing count pheasant census was attempted on the islands of Hawaii and Maui. Inclement weather during the peak of the crowing on Hawaii greatly curtailed the study and hence the results are probably not as accurate as might be expected. A route of 12 stations was established in the Pohakuloa-Waikii area on the island of Hawaii. Starting on February 28 an attempt was made to make a count at least once a week on this route. Due to extremely high winds and heavy rainfall during most of April and the first part of May, no counts could be made. During May spot counts were made in other areas throughout the island of Hawaii. The data concerning these counts are presented in Table VIII.

Not enough data is available to make an accurate population estimate; however, these indices will prove valuable for comparison with next year's counts. Map I shows the areas where crowing counts were made on the island of Hawaii.

PHEASANT NESTING STUDY ON MAUI

On the island of Maui a similar nesting study was conducted; however, due to unavoidable circumstances, the study was not started until May. Sixty-two nests were discovered in

three study areas. Of these nests 31 or 50% were successful which is almost three times as successful as the nests found on Hawaii. Seventeen or 27.4% were destroyed and 14 or 22.5% were deserted. (Table IX).

Out of 62 nests found, 13 or 20.9% were active and 49 or 79.1% were inactive. (Table X). These figures compare fairly closely with those found on Hawaii. The outcome between active and inactive nests on the two islands differ considerably. About 30% more inactive nests were successful on Maui. The amount of nests destroyed appears to be about equal between active and inactive nests which would suggest that human interference has little to do with nest destruction. The amount of desertion was not nearly as great on Maui as it was on Hawaii, but the trend was similar with active nests showing a considerably greater percentage which suggests that human interference does increase the amount of desertion.

When the results are broken down into study areas, we find that area No. I (Map III) is the most successful and also the most productive as far as the number of nests is concerned. This area is one that has been stocked with pen-reared pheasants for a number of years. A local gun club controls the hunting on the area. The cover appears to be excellent nesting habitat with a dense stand of puakeawe (Styphelia tamerameiae) brush covering the slopes of Haleakala between 4 - 6,000 feet. An interspersion of grass and weeds among the brush clumps appears to offer the best nesting habitat. Almost every nest was located in or directly to the lee of a clump of puakeawe.

The comparatively small amount of destruction is believed to lie in the fact that there are fewer mongooses above 4,000 feet than there are in the lower elevations. No reason is apparent for the desertion and since it is so low, it is not of too great importance in this area.

Area No. II lies below 4,000 feet and is looking in the punkeawe grass association. This area is grazing land which is very open with little interspersion except for scattered Eucalyptus groves. Since the sample is small in this area, it probably does not reflect a truly accurate picture of nesting success. Nests are not nearly as prevalent in this area as in Area No. I. Area No. III lies very near the sea coast between 0 - 1,000 feet. The principal cover is Lantana brush with a thin under story of grasses and weeds. Most of the habitat is located at the edge of pineapple fields. Rattoon pineapple fields also offer good nesting sites. The pineapple fields are not cultivated after the first year and weeds and grass are allowed to grow between the rows. This type of habitat will draw the birds in from outlying areas. A local sportsman's group has planted a few birds in the area and have reported a gradual increase. A number of nests were found in the new pineapple fields at the base of plants that were 8 to 12 inches in height. All of these nests were within 10 feet of the edge of the field. The desertion here is probably due to human interference as there are a number of workers going through the fields constantly. This sample is also too small to be significant. Only a short period of time was spent here. It

has possibilities of becoming a good pheasant area if management measures are taken.

AVERAGE CLUTCH SIZE

When all the nests are considered the average clutch size was 11.2 which is lightly lower than the overall average for the island of Hawaii which was 12.2.

NEST DESTRUCTION

Only 17 nests or 27.4% were destroyed on Maui compared with 46.6% on Hawaii. It is not possible to determine the reason for the lower amount of destruction unless the fact that most of the nests on Maui were found above the optimum range for the mongoose. All but three of the nests that were destroyed are believed to have been destroyed by mongoose or possibly feral cats. Domestic dogs destroyed one and humans accounted for two nests. The type of destruction was exactly the same as that found on Hawaii. (Plate IX and X).

NEST DESERTION

Only 14 nests or 22.5% were deserted on Maui compared with 39% on Hawaii. This may be explainable by the fact that there are very few feral pigs and only a few head of cattle in the study areas. The writer has not had the opportunity to interview local ranchers on Maui; therefore, no opinions are available.

FERTILITY AND HATCHABILITY

Only nine of the successful nests were intact enough to make an accurate count of the eggs. Out of 97 eggs that

were laid, 83 hatched for an average of 90.7% which is about 35% better than the average on Hawaii. This success compares favorably with most studies on the mainland. It is hoped that a climatic study in connection with hatchability will reveal why the average is so much better on Maui. Seven of the nine eggs that did not hatch were believed to be infertile, one had an embryo and one was cracked. 7.2% of the eggs were infertile and 1% of the loss was due to embryo mortality. (Table XI).

BROOD DATA

Brood studies have just recently begun on Maui. Thirty-three good broods have been seen with an average of 3.8 per brood which is slightly under the average for Hawaii. Almost all of these broods were seen in Area No. I. A thorough analysis of the brood studies will be presented in the following quarterly report.

CROWING COUNT DATA

Spot crowing counts were made during the latter part of April on Maui.

Map No. III shows the areas where these counts were made. It is not possible to make an accurate population estimate because of insufficient data. The counts, however, will be used as indices to be compared with counts made on Hawaii and counts made next year on Maui. The counts represent the average calls heard in a 2-minute period at sunrise. (Table XII). The highest number of calls heard was in the Puu Nianiau section in

Area No. I. This count compares quite closely to the counts in the [illegible] and Hana areas on the island of Hawaii. No crowing at all was heard in Hana, Maui. This agrees with observations [illegible]; 1949, at Hana. No birds were seen in two days of strip counting. Only one count was heard in the Waikapu area [illegible] management area was recently started. There were no [illegible] prior to this time that 34 pheasants were [illegible] after game bird watering devices had been installed.

Area No. II yielded the second highest counts on Maui [illegible] an average of 7.6 per two-minute period. This count compares closely with the Keamoku area on Hawaii. Area No. III had a very low count of 1.4 calls per two-minute period. The [illegible] census in this area in August, 1949, reveal very few pheasants. If the future when personnel is available, a much more extensive crowing count census will be conducted on Maui.

CALIFORNIA VALLEY QUAIL NESTING STUDIES

It was discovered that quail nests were practically impossible to find because of their inaccessible locations. Most of them were located at the base of a horizontal limb of a manzanita tree and were impossible to see. Five nests were discovered in approximately ten days of searching. It was decided that full time work on the pheasant nesting study would be much more profitable than devoting half time to pheasants and half to quail. Brood counts are being made on the California valley quail and the data will be presented in the following quarterly report.

Submitted:

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Approved by:

Division of Fish and Game

By: Vernon E. Brock
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Title: Director

Date: July 15, 1950

TABLE I

PHEASANT DENSITIES AND SEX RATIOS

[illegible]	Crowing Count Cocks/sq. mile, not adjusted	Sex Ratio Cocks/100 Hens	Birds per sq. mile Cocks	Hens	Total
[illegible]	58	100	44	44	88
[illegible]	75	100	56	56	112

TABLE II

COMPARISON OF OUTCOME OF NESTS IN DIFFERENT AREAS ON HAWAII

Area	Total Nests No.	%	Successful No.	%	Destroyed No.	%	Deserted No.	%
[illegible]	41	39%	3	7.3%	27	65.8%	11	26.8%
[illegible]	52	49.5%	12	23%	19	36.5%	25	48%
[illegible]	12	11.5%	4	33.3%	3	25%	5	41.6%
Total	105	100.0%	19	18%	49	46.6%	41	39%

TABLE III

COMPARISON OF OUTCOME OF ACTIVE AND INACTIVE NESTS ON HAWAII

TOTAL NESTS			SUCCESSFUL				DESTROYED				DESERTED			
Active		Inactive	Active		Inactive		Active		Inactive		Active		Inactive	
%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
28.5%	75	71.5%	9	30%	10	12.3%	6	20%	43	57.3%	16	53.3%	25	33.3

(Four nests were destroyed after desertion)

TABLE IV

[illegible] SIZE OF INCUBATED CLUTCHES ON HAWAII

[illegible]	[illegible] of Nests	No. of Eggs	Average Clutch
[illegible]	3	36	12.0
[illegible]	16	177	11.0
[illegible]	4	37	9.2
[illegible]	23	250	10.8

TABLE V

[illegible] OF TOTAL COMPLETED CLUTCHES ON HAWAII

[illegible]	[illegible] of Nests	No. of Eggs	Average Clutch
[illegible]	13	164	12.6
[illegible]	36	453	12.5
[illegible]	5	45	9.0
Total	54	662	12.2

TABLE VI

LOG FERTILITY AND EMBRYO MORTALITY ON HAWAII

Total Eggs	Infertile		Embryo Mortality		Hatched	
	No.	%	No.	%	No.	%
88	19	21.6%	19	21.6%	50	56.8%

TABLE VII

AVERAGE BROOD SIZES ON HAWAII

Area	No. of Broods	Average Size
Mauka	20	3.2
Cornfield	4	5.7
Puu Laau	25	4.0
Pohakuloa	3	6.0
Total	52	4.0

TABLE VIII

AVERAGE COCK CALLS PER TWO MINUTES

ON HAWAII

Area	Crowing Count Calls per 2 minutes
Pohakuloa	19
Waikii	58
Mana Road	21
Keanakolu	6
Ohaekea	29
Puu Laau	75

TABLE IX

COMPARISON OF OUTCOME OF NESTS IN DIFFERENT AREAS ON MAUI

Area	Total Nests No.	%	Successful No.	%	Destroyed No.	%	Deserted No.	%
No. I	43	69.2%	24	55.8%	12	27.8%	7	16.2%
No. II	9	14.5%	4	44.4%	2	22.2%	3	33.3%
No. III	10	16.2%	3	30%	3	30%	4	40%
Total	62	100.0%	31	50.0%	17	27.4%	14	22.5%

TABLE X

COMPARISON OF OUTCOME OF ACTIVE AND INACTIVE NESTS ON MAUI

TOTAL NESTS				SUCCESSFUL				DESTROYED				DESERTED			
ive No.	%	Inactive No.	%	Active No.	%	Inactive No.	%	Active No.	%	Inactive No.	%	Active No.	%	Inactive No.	%
20.9%		49	79.1%	5	38.6%	26	53%	4	30.8%	13	26.5%	4	30.8%	10	20.4%

TABLE XI

EGG FERTILITY AND EMBRYO MORTALITY ON MAUI

Total Eggs	Infertile		Embryo Mortality		Hatched	
	No.	%	No.	%	No.	%
97	7	7.2%	1	1%	88	90.7%

TABLE XII

CROWING COUNTS ON MAUI

Area	Cock Calls per two minutes
No. I	18
No. II	7.6
No. III	1.4